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ABSTRACT

This handbook is designed for use in conjunction with staff training seminars designed to provide teachers and administrators with a framework and procedures for designing and implementing effective applications of technologies in the curriculum. The intended outcome of the seminars is the development of comprehensive programs including the identification of specific programmatic areas by subject; the identification of student and staff competencies; and the projection of staff training requirements and budgets needed to accomplish specific program components. Chapter one provides an introduction to the program. A conceptual framework which focuses on concepts and principles in educational technology applications is presented in chapter two. Chapter three describes the tasks and activities that need to be accomplished to design and develop appropriate applications of technology throughout the curriculum, taking into consideration both curriculum development and instructional development issues. Illustrations throughout the document demonstrate basic curriculum development components and delineate specific action steps in educational strategies, integration of microcomputers into the curriculum, and the development of a curriculum framework. Appended are a checklist of planning steps, a sample instructional unit plan, a scope and sequence matrix for the cognitive levels and instruction sequences involved in developing writing skills, and a checklist for integrating technology into the curriculum. (41 references) (DB)

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Technology in the Curriculum

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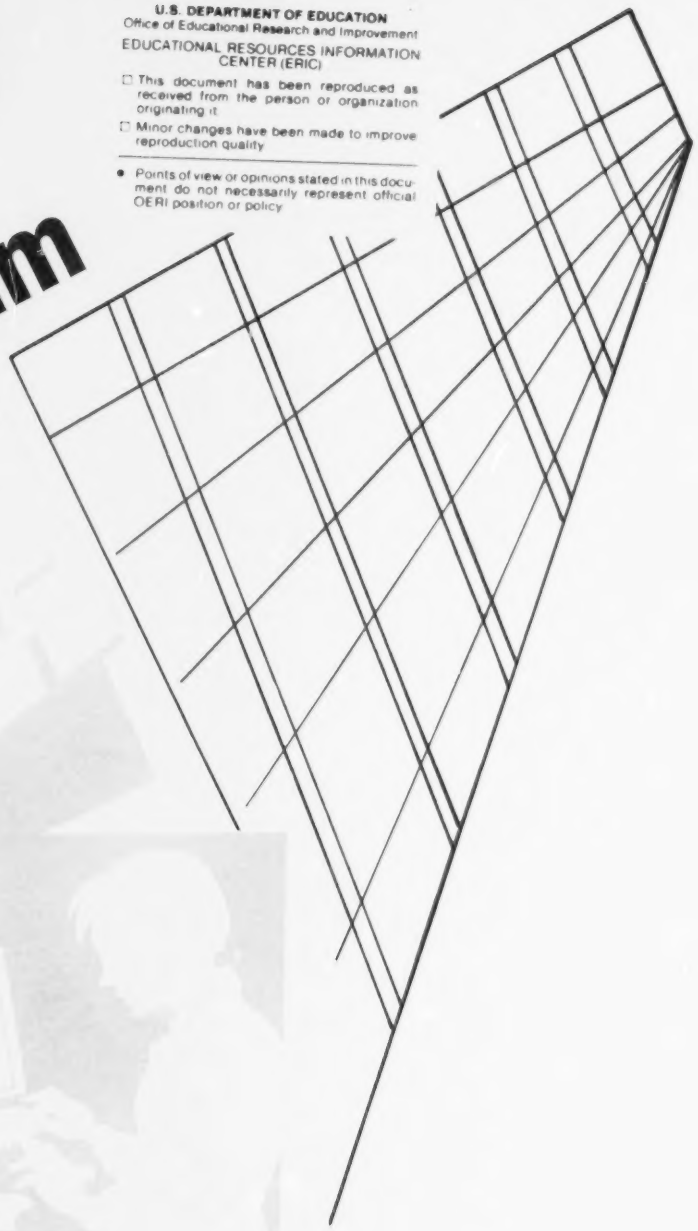

A Handbook for Integrating Computers and Related Learning Technologies Throughout the Curriculum

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About this Publication

This publication is one component of the Computer Applications Planning (CAPS) series, a continuing service of the Merrimack Education Center. It is intended for the use of administrators of local schools, state departments, or field service centers such as intermediate units or technology centers. This publication should assist educators in their quest for effective practices on technology implementation.

The staff welcomes and profits from the thoughtful ideas, suggestions and comments contributed by participants from our seminar series. Correspondence concerning the CAPS seminar series and technology applications within the curriculum should be addressed to the Merrimack Education Center.

Because these publications are intended as a series of "tools" for use in local schools, we have provided the publications and separate components in loose-leaf format to serve as part of a planning notebook.

Prepared by the

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PREFACE

Computers and other learning and information technologies—videodiscs, online databases, electronic networks—are stimulating considerable activity in schools. In just a few years, the growth in the availability of hardware and software has spurred attention to the need for technologically literate students. Even as educators grapple with defining technological literacy, new demands are forming for integrating computers into the curriculum. Each successive need challenges educators to look beyond immediate and simplistic solutions to the potential of these new learning technologies, to undertake a revitalization of all or most of what goes on in schools, and to keep pace with the changes taking place just outside the classroom door.

At the Merrimack Education Center (MEC), we are helping educators to use technology as a resource for individual and organizational improvement. MEC is one of eleven Technology Lighthouse Projects funded by the National Diffusion Network (NDN) in the U.S. Department of Education. In its Lighthouse role, MEC has worked with state departments of education, intermediate service agencies, and school districts in developing comprehensive technology applications plans. We have also worked with teachers and administrators to develop, implement and evaluate instructional applications in several subject areas. In addition, we have trained hundreds of teachers and administrators in scores of workshops and seminars. ***Technology in the Curriculum: A Handbook*** is based on our wide range of experience.

Based on our work with Computer Applications Planning (CAPS) and related training services, we received support from the U.S. Secretary of Education in 1983 to work with middle schools (grades 6 through 8) in three Massachusetts school districts on the development of applications of technology, particularly microcomputers, in three basic skills areas—writing, problem-solving, and research/study skills. The purposes of the Technology Applications in Basic Skills Project (TABS) were to: (1) develop a comprehensive process for integrating new learning technologies into the curriculum; and, (2) develop replicable programs that use microcomputers and related learning technologies to enhance instruction in basic skills. The project addresses the issues associated with efforts to introduce new learning and information technology into the instructional program of the typical junior high or middle school.

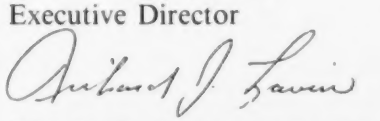
As a result of our experience and research studies this publication identifies planning activities and describes the tasks that district personnel can follow in developing applications of technology. This handbook supplements our earlier publication in this series, the Computer Applications Planning **Guidebook.** These publications are used in conjunction with training seminars available through MEC. These seminars are designed to help district staff members develop planning capability and capacity to offer curriculum-based, comprehensive technology application programs.

The intended outcome of using this ***Handbook*** is a comprehensive program including identification of specific programmatic areas by subject; identification of student and staff competencies; and projection of staff training requirements and budgets needed to accomplish specific program components. The reader may wish to consult the list of references for additional information and planning guides.

Technology in the Curriculum: A Handbook draws heavily on our experiences with CAPS and with TABS. The ***Handbook*** serves as a companion to the ***Guidebook,*** extending its focus beyond district-level planning to school and classroom curriculum development and instruction. The handbook shares many of the concepts of the planning manual/guidebook, however, and the most relevant of them are reiterated and expanded throughout this publication.

A central theme of work at the Technology Lighthouse is that in order to use the new learning technologies effectively, educators will need to maintain a clear focus on some basic and simple understandings about education and schooling, and about curriculum and pedagogy. This theme serves as a central focus for the ***Handbook.***

Richard Lavin, Ed.D.
Executive Director



Merrimack Education Center

TECHNOLOGY IN THE CURRICULUM

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I. INTRODUCTION

A. Rationale and Purpose

Perhaps the most serious challenge to educators in the years ahead will be the task of linking appropriate applications of new information and learning technologies with the school curriculum. These technologies, particularly but not only the computer, can help students to learn more effectively and productively, develop motivation and enthusiasm for learning, and prepare for careers. For this conviction to be transformed from a vision to a reality requires considerable effort. Further work is needed on developing conceptual frameworks, preparing curricula, and coordinating program implementation.

Our purpose is to provide teachers and administrators with a framework and procedures for designing and implementing effective applications of technologies throughout the curriculum. Our approach to technology education is curriculum-based and focuses on how the curriculum can be improved by the use of technology tools. We are particularly addressing our work to district-wide curriculum coordinators and computer applications specialists, and to principals and secondary school department heads or subject area specialists.

While we are strong proponents of entrepreneurial innovation as an approach to school improvement, our experience indicates that learning from our pilot efforts and early tries can be most productive when done within a commonly shared development framework. Educators' responsibilities to ensure equitable student access to learning technologies and to focus and maximize very limited school improvement resources require that they start with some common understandings. The process delineated in this handbook shows how to nurture and sustain the entrepreneurial activities of the "early adopters" while assuring a uniform and effective implementation of required program objectives and activities.

The most appropriate uses of new learning technologies are as tools that help students become more productive and effective learners and that support a revitalization of the existing curriculum. This rationale is based on our observations and assessment of the state of the art with respect to technology applications in education, our analysis of trends in schooling, technology and society, and on our experience in helping over one hundred school districts throughout the country to implement applications of computers and other new learning technologies. We have found that many such applications are uncoordinated and separated from the total school curriculum. Concurrently, we recognize that, as documented by the many national reports and studies, curriculum revitalization and educational reform in general are very much needed. We view these two sets of occurrences as mutually compatible and reinforcing.

This handbook, then, is addressed to two basic questions:

- How can existing curricula be designed to accommodate and make maximum use of learning and information technologies, particularly microcomputers?
- How can these technologies be used as catalysts to revitalize existing curricula?

While these questions are similar to those addressed in the ***CAPS Guidebook***, we address them here in greater detail and provide illustrative examples. Our focus in the ***Guidebook*** is on district-wide program planning. Here, it is on curriculum planning—the translation of broad program initiatives into curriculum designs and instructional plans (see Exhibit I-1 page 4). We assume that some form of ***program*** planning has been accomplished before moving to the detailed curriculm design addressed in this handbook. In addition, we recognize that curriculum design and instructional development, however detailed, are insufficient to a comprehensive program. Additional work must be done to prepare teachers and administrators to conduct instructional systems design and to organize and implement the program. These tasks also are covered in the district-wide plan, but may need to be addressed in more detail once a specific curriculum focus has been identified. For example, our ***CAPS Guidebook*** manual cautions:

> Integrating computer competencies into the existing curriculum is a major undertaking. Existing objectives may need to be modified, and new ones may need to be developed. During this

process, the planning committee should note areas in the curriculum that need further examination or development.

Because of its importance and its difficulty, the principal focus of this handbook is on curriculum development for appropriate utilization of technology. Only passing attention is given to detailed staff development and to organization and implementation tasks. Many publications are available providing information on critical issues of hardware, software selection and purchase, and implementation options for utilizing technology in schools and classrooms.

To bridge from the broad, district-level program planning issues addressed in the CAPS ***Guidebook*** and the school and classroom-based curriculum and instruction issues that are the primary focus of this handbook, we need to give some attention to some preliminary considerations.

B. Preliminary Considerations

Incorporating new learning and information technologies into the curriculum involves more than implementing a number of broad action steps in serial fashion. The issues are so complex and the interactions so numerous and diverse that one needs to step back and survey the landscape before moving to the details of the curriculum and other operational considerations. More than ever, teachers and administrators will need a systems view—an eye for the whole chessboard. Of course, we cannot expect that nothing will be done unless and until all other variables are addressed. It is critical, nevertheless, to recognize that undertaking a major innovation such as technology integration will impact nearly every aspect of the operation of the schools. Technology is a relatively new phenomenon, but its novelty should not cause us to forget or ignore all we know about the forces at work within schools. Knowledge of current practices, the "pockets of innovation" within the district, and of the dynamics of change are essential to the tasks of planning.

Even as CAPS program planning is being conducted, it becomes apparent that planning for technology applications cannot take place in a vacuum. Because the district has other program priorities that must be addressed, deciding about the details of curriculum/technology integration must be preceded by other decisions. We recommend that questions such as the following be answered before moving to curriculum design and instructional development.

1. **Where to begin?**

   Because integration efforts cannot be initiated in all areas at once, choices about an initial form must be made. The following criteria may be helpful in making a decision:

   Student need. Is there student performance information available that indicates achievement inadequacies?

   Pockets of innovation. Are there some efforts already underway that can be used as springboards for a comprehensive development effort?

   Staff readiness and commitment. Are teachers in one area more ready and willing to make the necessary commitment?

   Return on investment. What applications will yield the largest investment in terms of student impact, equitable access, curriculum and organizational renewal? How will we determine cost-benefit ratios?

   Resources available. Will limited development and improvement monies restrict or determine the options available?

2. **What other curriculum improvement projects are planned or underway?**

   It may be that teachers are already working on curriculum revision in a specific area, such as improving the science curriculum at the middle school or integrating problem-solving into the social studies courses. Are there opportunities for incorporating a technology applications focus into these projects?

3. **What major staff development activities are planned or underway?**

   Are teachers broadening and improving their instructional strategies and techniques? Are elementary school teachers being trained to give more attention to science? Are there opportunities for incorporating a technology applications focus into these activities?

4. **How do the technology initiatives interact with other priorities being addressed in the school or school district?**

   Will other initiatives impact positively or negatively on the technology effort? Are there opportunities for synergy? How much change can reasonably be designed and implemented in each school year? What type

and level of planning will be required to realize increased synergy? Without attention to district-level planning, the technology/curriculum integration work done at the school and classroom level may itself not be integrated with other program initiatives.

5. **What level of resources can be devoted to integration over a multi-year period?**

   What budget level is reasonable to expect will be available for this initiative? What sources of new monies might be tapped?

These questions cannot be answered in isolation; responses to one interact with responses to others. Thus, the process of arriving at even general and preliminary answers to them will require the systems view advocated earlier. Having all of the answers is not nearly as important as recognizing that each question reveals still another aspect of the innovation and improvement process that will impact on the total effort. The planning committee determines the focus for curriculum priorities and will examine applications already in place to further extend and elaborate the district program. These existing "pockets of innovation" within creative classrooms can be incorporated into the overall district programmatic plan.

Before moving on to the detailed work of curriculum integration, the planning team should have:

- formed a vision of the future of schooling based on anticipated directions in curriculum, the organization of schools, learning and information technologies, and in the nature of the student as learner;
- communicated the vision to the faculty as a stimulus for discussion and development;
- communicated the vision to the school board and the community through a philosophy, mission and goals;
- selected an area(s) of focus (i.e., subjects or content areas) for initial integration efforts;
- established an approximate level of resources available;
- identified other curriculum improvement projects and determined possible areas of interaction; and,
- inventoried what technology applications are already in place.

It is assumed that the planning committee has prepared the groundwork and established a perspective from which to view the district program. Technology is viewed as an essential educational tool, one which can enhance student learning in all subjects at all grade levels. From this perspective, the planning committee and curriculum sub-committees expand the scope of the curriculum, incorporate the innovative and creative examples of technology already occurring and detail the developmental tasks of instructional systems design to carry out the planning team's recommendations. (For illustrations and suggestions to complete these planning steps, see the ***CAPS Guidebook.*** The CAPS checklist of steps is reproduced here in Appendix A.)

C. Overview of Contents

Because of the importance and difficulty of incorporating technology into the curriculum, we present a conceptual framework for our approach in Chapter II. This framework is not meant to be a treatise on curriculum development. The bibliography contains ample references to such material. Chapter II focuses on those concepts and principles that impinge on technology applications and that can be used to support the revitalization and delivery of the curriculum and the focus of computer activities integrated across the curriculum subject areas. The recommended approach incorporates computer concepts with traditional skills covered in existing curriculum subjects separately or through teaming and interdisciplinary exchange.

Chapter III presents a detailed description of the tasks and activities that need to be accomplished to design and develop appropriate applications of technology throughout the curriculum. In addition to describing the design and development process, we give special attention to critical issues and to illustrations drawn from our work with many teachers and administrators. Examples of instructional applications are provided illustrating instructional objectives and suggested instructional methods, materials and assessment procedures

The curriculum/technology integration process employed in our work is a curriculum-driven one, as distinct from a technology-driven one. Rather than allow available technology to determine curriculum applications, we start with basic curriculum improvement needs and look for technologies that may address those needs.

The sequence and the orientation are critical to the integration process.

Although the curriculum development process is presented here in a sequential format, in reality some of the steps are conducted at the same time, or are repeated throughout the overall process. For example, while curriculum development initially precedes staff development, often staff development is organized around curriculum development issues and activities.

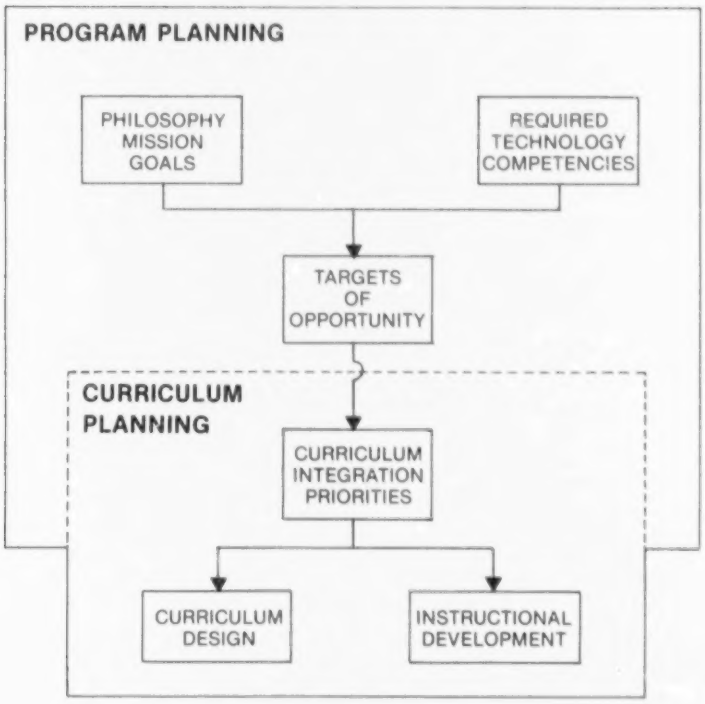
This handbook defines the basic curriculum development components and delineates specific action steps, important considerations, and specific issues that need to be addressed. We have included illustrations throughout to demonstrate what our recommendations look like in practice. Some of the material deals with basic principles and practices related to creating an integrated curriculum. In treating these generic principles, we recognize that we are reviewing what may be common curriculum development knowledge; our experience, however, is that this common knowledge may not be common practice. Furthermore, existing conceptualizations of curriculum may go through a restructuring process as technology advances. In some cases, availability of emerging, state-of-the-art software programs will necessitate a cognitive restructuring for curriculum subject areas and hierarchies.

Indeed, a theme of this handbook is that employing appropriate applications of technology in the major subject areas requires a reaffirmation of many basic principles and practices of curriculum and instruction. Although we give some attention to general curriculum and instructional issues, this attention is used primarily as a context for presenting in detail the special requirements of incorporating appropriate applications of technology into the major content areas. To treat any of these general issues and topics in any detail is beyond the scope of this handbook. The Appendix contains citations to general curriculum and instruction literature that we have used in our own work.

EXHIBIT I-1

TECHNOLOGY IN THE CURRICULUM

LEVELS OF PLANNING



Because the CAPS model is curriculum-based, we give special attention to the conceptual underpinnings of our approach. This chapter presents a discussion of key concepts and understandings related to technology and the curriculum. In addition, we provide a brief analysis of directions in curriculum reform that serve as a context for technology integration.

A. Key Concepts and Understandings

The task of incorporating technology into the curriculum is essentially a curriculum issue and secondarily a technical one. Without an appropriate curriculum, educators are unlikely to realize the maximum potential of the computer (or any other learning/information technology) in the classroom. Deciding whether computers and software can be used effectively requires that teachers and administrators first decide what it is that is important for students to know and be able to do. Only then can they decide whether computers and related technologies are appropriate. Planning decisions made by the district computer committee supported by the board of education, provide direction for subsequent activities and tasks detailed in the district-wide computer instruction program.

Integrating technology into the curriculum *and* undertaking concurrent curriculum improvement is a long-term and complex task. Given resource limitations and other constraints, we propose an incremental, multi-year approach to the task, particularly to using learning technologies to support the curriculum. As recommended in the ***CAPS Guidebook,*** setting priorities for program development over a three-to-five-year period permits a phasing and staging of programmatic responses that are congruent with the district's philosophy and goals.

The interest in using computers in the classroom coincides with a number of other developments in education:

- an awareness that the growth of information and knowledge is outstripping teachers' abilities to manage it using traditional teaching methods;
- the increasing availability of technological tools to access, store, process and retrieve information provides an opportunity to consider how the curriculum can be improved by the use of technology;
- a nationwide curriculum reform effort that advocates giving equal time to teaching discipline-specific procedural knowledge and skills in conjunction with facts and concepts;
- a reemphasis on teaching students the skills needed to learn independently; e.g., critical thinking, study skills;
- a state and national search for excellent models of learning that incorporate characteristics of effective schools seeks out applications across all curricular areas.

We do need to keep our eyes on what existing and anticipated technologies can do for us, but the primary focus must be on what the curriculum needs to be — on what students ought to know and be able to do to learn more productively and to live and work successfully in the twenty-first century. Numerous educators and futurists have delineated the many curriculum reforms that are required. Goodlad (1983), Sizer (1984), and Boyer (1983) argue for major changes in the curriculum and in the organization of schools. DeBevoise (1983) suggests increased attention to "new" basic skills such as:

- evaluative and analytic skills
- critical thinking
- problem-solving
- organization/reference skills
- synthesis
- application
- creativity

New learning and information technologies are a stimulus to rethink what are the essential "basic skills" for the future. Basis skills include learning to use new technological tools to learn more productively and effectively. Recognizing the emerging centrality of information in our society, Grogan (1984) suggests three skill areas that all students will need to master:

1. the ability to analyze the correctness and completeness of information.
2. decision-making skills to identify an appropriate course of action.
3. the communication and interpersonal skills to implement a given course of action.

Mary Alice White, Professor of Psychology and Director of the Electronic Learning Laboratory at Teachers College, Columbia University, predicts that technology will: 1) alter the learning process; 2) create a new psychology of learning; 3) change learning content; 4) alter educational environments; 5) enable almost anyone to learn almost anything; and, 6) provide a curriculum of choice. Teachers and administrators wishing to take advantage of new learning and information technologies will need to contemplate such predictions and their implications for curriculum reform, particularly in avoiding the application of technology to teaching knowledge and skills that are, or will become, outmoded. In consideration of this perspective, we have found the following principles useful in developing curriculum/technology integration.

- Technologies are *means* of teaching and learning, not *ends*. As prominent as these new machines may be presently, our goal should be to make them transparent in the curriculum, much as pencils and paper are now.
- Developing appropriate applications of technology requires a futures perspective in at least five areas: students, the curriculum, school organization, learning technologies, and society itself. How do students learn? What will citizens living in the 21st century need to know and to be able to do? How can schools and classrooms be organized to take best advantage of existing and emerging learning technologies? What new technologies can we expect to be available to schools within the next five years? What kind of a society is evolving in our country and the world? As difficult as it is to answer these questions definitively, our applications must anticipate trends and future needs. While our focus needs to be on the here and now, our peripheral vision needs to accommodate a long-range and broader perspective.
- Technology may allow teachers and administrators to do things that they always knew were optimum, but which could not be implemented because of organizational, personnel or resource limitations and barriers. Such ideals as mastery learning, continuous progress, and independent learning are likely to become increasingly more reasonable expectations for all teachers and students.
- Much of our progress to date in using computers and related learning technologies has come from the efforts of individual teachers and adminstrators acting as innovators and entrepreneurs. It is important to use this base of innovative experience in the development of a district and school-wide framework.
- The task of incorporating technologies into the curriculum is a major undertaking, requiring a long-term commitment of time and resources for staff development, curriculum revision, and implementation support and assessment. The level of commitment required often is underestimated by administrators and policy makers.
- Because there is so much we do not yet know about the operational details of technology applications, pilot programs should be emphasized in the early stages of development. Such small-scale efforts allow for learning from our tries and minimizing the size and negative impact of the inevitable mistakes and false starts.
- The increased attention to teaching students how to use new learning technologies requires a comprehensive and deliberate instructional plan that is linked to all major subject areas in the school curriculum and that helps us reexamine the traditional subject/programmatic divisions of the curriculum in place.
- We will need to undertake a process of mutual adaptation and accommodation in which *what* is taught will change as much as *how* it is taught.
- The new learning technologies can be used effectively to support a curriculum that is focused on procedural skills and knowledge (e.g., writing, learning/study skills, and problem solving).
- Given that large-scale curriculum revision may take several years, we have found that identifying targets of opportunity within the curriculum, as it is being revised, is a judicious approach to incorporation of learning technologies. These targets are the curriculum areas or learning outcomes administrators and teachers identify as priorities needing increased attention and which the new technologies can support.

Technological literacy needs to be viewed from two perspectives: 1) the set of competencies that constitute what students need to know and be able to do with technology; and, 2) the set of applications of computers and related technologies that help to deliver the expanded curriculum and help students to be more productive learners in each subject area. For curriculum integration in the Technology Applications in Basic Skills (TABS) project, we used

the following definition, adapted from one prepared by the National Center for Educational Statistics.

> Technological literacy represents *knowledge* of computer and related information and learning tool applications and the *ability* to use these applications for learning purposes, including an awareness of computer languages. Being technologically literate means that we have the knowledge and understanding to function in an information age. A technologically literate person would have awareness, knowledge and understanding of various technology equipment and software, and skills in using them as problem-solving tools, for information management and creative learning instruments.

Integrating learning technologies into the curriculum entails the use of computers, software and related hardware and support materials to help students learn more effectively and productively. Whether the computer is used to instruct or to be instructed (for example, through programming), its most important use is as a tool to serve the curriculum.

The classroom is already an estimated two knowledge generations behind the cutting edges of many subjects — and the gap is daily widening.

Allen Schmieder

B. Directions in Curriculum Reform

Understanding the direction that curriculum reform needs to take is a necessary first step in deciding how new learning and information technologies can be integrated appropriately into the elementary and secondary school curriculum. Curriculum reform and its relationship to technology applications is a many faceted undertaking. We have noted four major trends that interact with technology integration efforts as they impact on the curriculum.

1. **Content/Process Curriculum Balance.** In nearly every subject area, educators are seeking increased attention to the discipline-specific procedural skills and knowledge that serve as the foundation for learning how to learn and that permit the student to demonstrate competence in each subject area. For example, in the area of writing, the shift is to increased attention to, and practice in, the writing process as opposed to stand-alone grammar, mechanics or spelling units. In social studies, the shift is to teaching the skills of the social scientist—observing, creating hypotheses, collecting and analyzing data, making judgments. In science and mathematics, increased attention is being given to the scientific method as an organizing principle in the curriculum. In all areas, the intent is to use the discipline-specific process skills as the framework for the curriculum, not a selection of facts or instructional materials. The result is a blend of instruction that helps students learn more efficiently how to learn, and how to make sense of the rapidly expanding body of new knowledge, in short, how to think, learn and perform in each discipline.

2. **Integration of Learning/Study Skills.** The teaching, by content area teachers, of such skills as outlining and notetaking, locating and selecting information, vocabulary development strategies and test taking is increasingly being promoted. The last few years have witnessed a resurgence in formal study skills programs, as separate courses or integrated into the content areas. This integration is motivated by the recognition that learning how to learn is a general capability that can be customized to support every content area. A further motivation is the realization that the growth of information and knowledge is outstripping the school's ability to manage and teach them using traditional means. The availability of technology throughout society—in libraries, homes and cultural educational organizations—will challenge educators to prepare students to access and manipulate information as independent learners.

3. **Increased Attention to Thinking Skills.** A third curriculum improvement movement is the increased attention to higher order thinking skills. This effort is taking many forms,

some of which have been with us for some time. In reading, the new imperative is to teach transformation and evaluation skills and concepts. Sometimes this reform takes shape in renewed interest in teaching critical thinking and problem solving. Other improvements focus on sophisticated conceptual skills, such as those on the higher end of Bloom's taxonomy (analysis, synthesis, evaluation). The number of programs devoted to teaching thinking skills throughout the curriculum is growing rapidly.

4. **Instructional Strategies.** Paralleling these curriculum reforms is renewed interest in instructional strategies that have been the topics of research for many years. Improvements in teaching require extending the range of instructional strategies employed, particularly to address different learning styles and higher order thinking skills. The heavy reliance on lecture and simple information dissemination strategies needs to be replaced by a wider repertoire of teaching techniques, including demonstration, simulation, observation, brainstorming, discussions and guided practice. A resurgence in interest in teaching effectiveness is under way, perhaps best demonstrated by the increased adoption of Madeline Hunter's work.

Attaining a better balance between teaching facts and teaching skills requires not only that we identify the important procedural skills in each subject or discipline, but that we improve strategies for teaching them. Because most teachers do not have as much experience in teaching process skills as they do in teaching concepts and factual information, we may need to give some attention to skill development strategies in the preparatory curriculum work.

The intended consequence of these change efforts is a better balance between the heavy information dissemination orientation of most teaching and the need to teach the thinking and learning skills that are always extolled but seldom well addressed in schools. This shift may be motivated in part by the information explosion that confronts teachers today. Not only is the knowledge base growing more rapidly, our access to the information is increasingly easier. Selecting the facts to teach is an increasingly more difficult task, particularly when they are so perishable. Teaching students how to identify, select, analyze, and communicate information may have considerably more lasting and useful effects than providing them with factual knowledge alone. Moreover, the integration of these skills into each discipline is more important than the integration of the new learning technologies.

We are only in the initial stages of these improvements. Nevertheless, they represent the central tendency of the shift that is taking place. They are important in and of themselves as needed innovations if schools are to prepare students for the twenty-first century. When viewed from the context of the available and emerging technologies, however, they take on added significance. For it is supporting much needed curriculum revitalization that technology can be most productive.

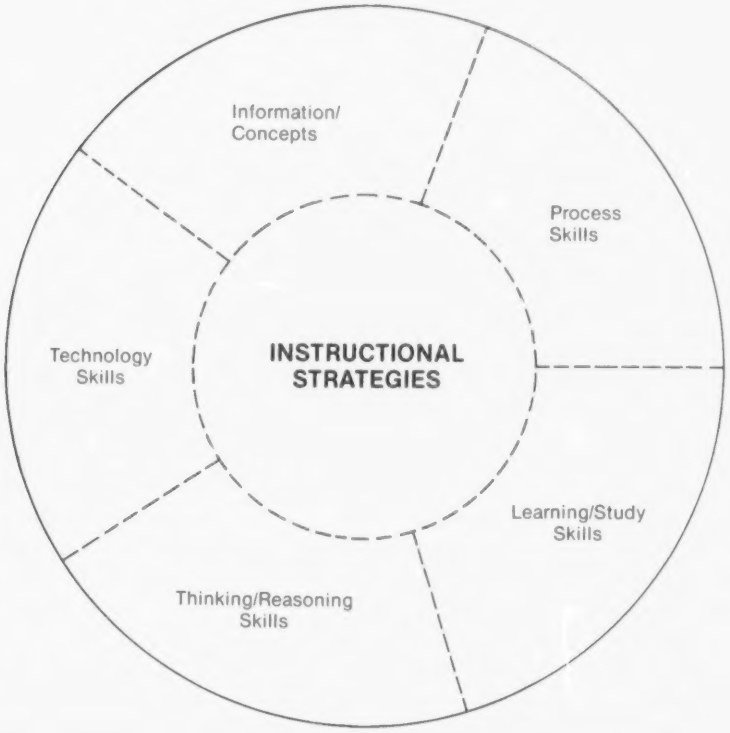
This brief overview of current directions in curriculum improvement serves as a foundation for the major principles and concepts that guide our work on technology applications in the curriculum. The notion of an integrated* curriculum is an underlying theme of most of the curriculum improvement research and practice. The rationale is that by blending skills instruction with appropriate information, the student will develop independent learning skills at the same time that he or she is mastering facts and concepts. New learning technologies, in exposing weaknesses in the existing curriculum, can serve as a catalyst to precipitate curriculum modifications. We do need to keep our eyes on what existing and anticipated technologies can do for us, but the primary focus needs to be on what the curriculum can become—on what students ought to know and be able to do to learn more productively and to live and work successfully in the twenty-first century.

Current broad curriculum efforts have accelerated work on specific issues and projects in different subject areas. The focus of an integrated curriculum (see Exhibit II-1) is a combination of information, discipline-specific process skills, and technology skills blended by the teacher using a variety of instructional strategies. The goal is to teach students how to think, learn and perform in each discipline using appropriate technology skills in these different subjects.

*Integration of skills and information *within subjects*, as distinguished from the integration among two or more subjects or disciplines.

EXHIBIT II-1

THE INTEGRATED CURRICULUM



TECHNOLOGY IN THE CURRICULUM

Preliminary Questions

- Where to begin?
- Connection to other curriculum development projects?
- Connection to other staff development activities?
- Connection to other district/school priorities?
- Available resources?

TWENTY-FIRST CENTURY SKILLS

- The ability to analyze the correctness and completeness of information.
- Decision-making skills to identify an appropriate course of action.
- Communication and interpersonal skills to implement a given course of action.

III. TECHNOLOGY in the CURRICULUM

We organize the process of technology integration into two major tasks: curriculum design and instructional development. Each task is composed of several steps.

In the *design* task, teachers and administrators examine their existing curricula and available technology to identify "targets of opportunity," areas within the curriculum that are in need of improvement and for which appropriate technology applications are available. In the final step of the design stage, a curriculum framework is prepared as a general map of the curriculum area to be addressed.

The *instructional development* task is focused on the preparation of instructional unit plans and curriculum packages. The unit plans serve as the principal guides to instruction, with a special focus on incorporating applications of technology. The curriculum packages provide the lessons and instructional materials used by the teachers in day-to-day instruction.

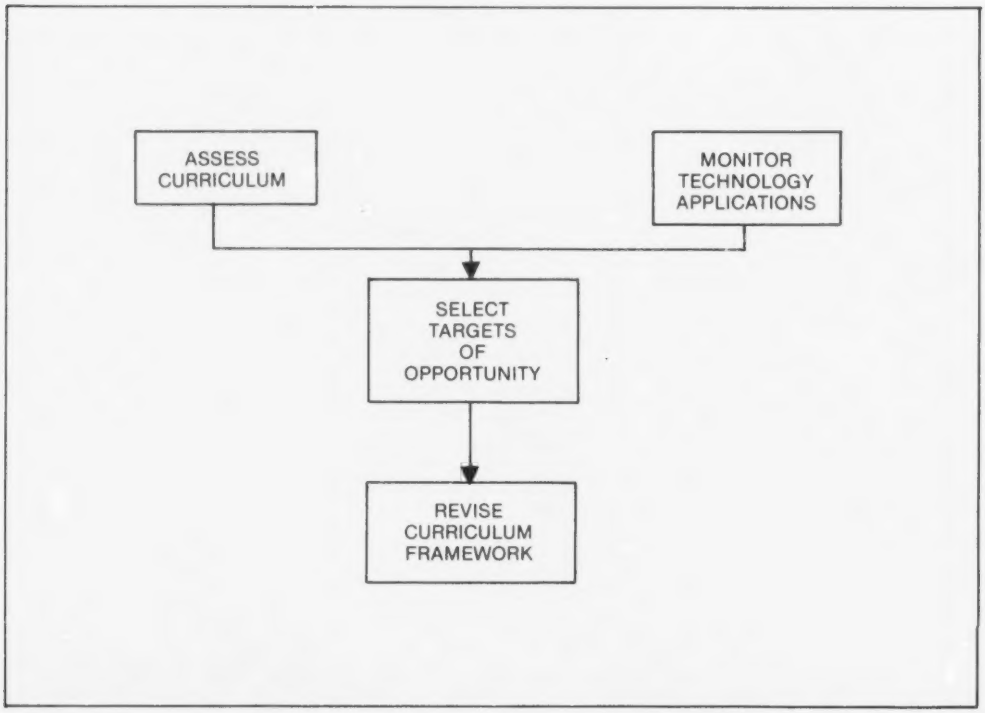
A. Curriculum Design

Improving curriculum with an eye toward incorporating appropriate applications of new information and learning technologies requires as a first step a dual examination of the existing curriculum and of existing learning and information technologies (see Exhibit III-1). Ideally, an examination of curriculum should be completed before an examination of what technologies are available to help deliver the new or improved curriculum. In reality, an awareness of what technologies are available often serves as a stimulus and catalyst for curriculum assessment. Teachers often identify curriculum improvement needs and possibilities by observing specific technological applications. Moreover, the potential uses of computers are expanding daily as new generations of hardware and software become available. New learning tools — videodisc and videotape, cable, satellites — add to the range of options available.

EXHIBIT III-1

TECHNOLOGY IN CURRICULUM DESIGN

LEVELS OF PLANNING



1. Assess Curriculum

Curriculum assessment is a complex undertaking that can take many forms. Generally, assessment is divided into two major tasks: monitoring curriculum implementation and evaluating curriculum outcomes. Typical curriculum assessment activities include:

- Reviewing professional association publications, educational studies, and similar sources for recommendations on curriculum improvements.
- Examining information on exemplary programs and practices related to the curriculum.
- Analyzing student performance information to identify skills and knowledge that are not being mastered satisfactorily.
- Studying instructional methods and management and instructional materials and equipment to identify needed improvements.

Whatever the specific techniques and measures used, it is important that teachers and administrators identify areas in the curriculum—sets of skills, particularly—that are not being mastered well. This is or should be a standard operating procedure in all schools.

Based on this review, teachers will be able to identify what improvements are needed in each of the curriculum components (i.e., content, process skills and technology tools). Teachers then examine the existing curriculum to identify the most significant gaps between the current, operational curriculum and what should be expected of future programs (i.e., process, content and technology skills).

2. Monitor Technology Applications

The rapid development and refinement of learning and information technologies makes monitoring new developments difficult. While computers and computer software are the central components of a technology-supported curriculum, new applications of videotape and videodisc, television, and satellite telecommunications are beginning to make contributions to learning in schools. Being aware of the capabilities of these new technologies is critical to making decisions about appropriate curriculum applications.

Monitoring available technologies that can be matched to specific curriculum areas can be a complex and difficult task. Here also, the abundant journal literature is helpful in reviewing a variety of applications. Given the computer-as-tool orientation of our conceptual approach, we are disposed to look for general purpose technological tools that help students accomplish tasks required in the curriculum. We are interested in developing learning productivity skills throughout the curriculum, and view general purpose technology tools as a principal means for extending students' abilities to collect, organize, analyze and communicate information and knowledge. These computer applications represent a variety of tool uses for computer technology including: word processing, manipulation of data and information in data bases, retrieval of information, electronic spreadsheets and the like. Many of these applications provide opportunities for the development of critical thinking and problem solving skills, as well, particularly when combined with exemplary instruction.

3. Select Targets of Opportunity

The relatively high cost of the new technologies requires that we get a good return on our investment. The abundance of applications available makes it possible to apply the computer and related tools to nearly every learning task. Not all applications, however, will yield substantial benefits over existing practice. Selecting targets of opportunity requires that teachers make appropriate matches between curriculum needs and available technology tools. Students need broad experience with computer applications in a wide variety of subject areas. Teachers need to determine what skills development and knowledge acquisition in each subject area might be best supported by learning technologies. In incorporating technology skills instruction into the content areas, for example, the social studies teachers may take lead responsibility for instruction in one or two specific skills, with teachers in other subject areas responsible for application and reinforcement. The following criteria may be helpful in selecting high yield curriculum applications that can be incorporated within subject centered curriculum:

- Degree of difficulty in teaching specific skills or knowledge
- Availability of quality software to address curriculum need
- Importance of the technology skills required

- Match between software and curriculum need
- Findings from research and practice literature

Exhibit III-2 illustrates some potential matches between curriculum needs and technology applications. Other more specific selection criteria are employed during the completion of the development and application tasks. At this stage, the district needs to base the selection of priorities on a determination of which technology applications will provide them with the most significant return on their district's investment.

Teachers use the scope and sequence of technological skills as a guide to determine whether students will have the necessary skills to apply the technology to the subject area learning tasks. For example, if the teacher of writing has identified the teaching of revision skills as a skill requiring special attention, she might want to use the word processor as a tool to help her teach revision skills or to help students make revisions in their own writing. In some cases, teachers may find a target of opportunity in using the computer to simulate or illustrate a concept or process that traditionally has been difficult to teach, such as recognizing paragraph structure and block movement in text editing.

4. Revise Curriculum Framework

Once teachers have identified targets of opportunity, the curriculum will need to be modified to take advantage of the new learning technology tools to be incorporated into instruction. As illustrated in Exhibit III-3, the curriculum framework is the overall instructional design—a broad view of the integrated curriculum. Our framework is based on the integrated curriculum design presented in Exhibit II-1 and constitutes the sum of what needs to be learned in any content area or discipline. Exhibit III-3 illustrates a curriculum framework in which process skills, information and concepts, and technology competencies are blended into instructional units.*

Because each instructional unit focuses on just one portion of the total curriculum, the overall curriculum framework for each subject area or discipline (see Exhibit III-3) needs to be well delineated. As teachers work on one piece of the curriculum for their technology application, it is important that they see the big picture: the entire set of skills, information and concepts that constitute the subject area. For this reason, the preliminary steps in the curriculum design require that the entire curriculum be laid out in

*To simplify the process, the incorporation of thinking/reasoning and learning/study skills is omitted.

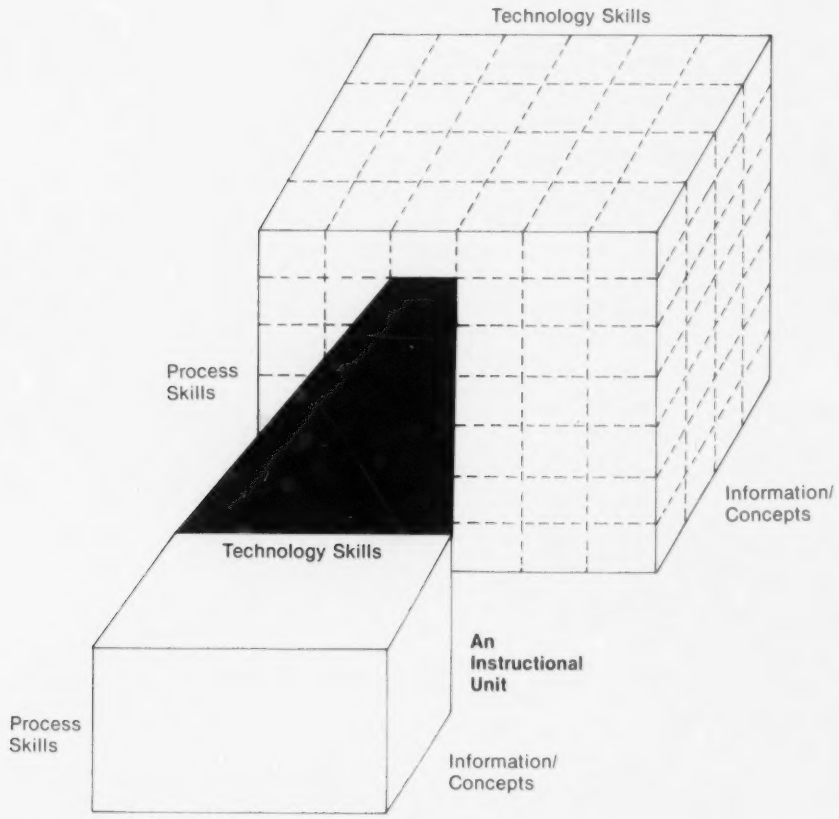
EXHIBIT III-2

TARGETS OF OPPORTUNITY: ILLUSTRATIONS

Select Curriculum Improvement Needs	Identify Available Technology
Writing	
Students do not revise their draft essays comprehensively and systematically.	Word Processing
Science	
Students do not manipulate data to analyze and evaluate variables.	Spreadsheets/ Databases
Mathematics	
Students do not understand essential concepts in algebra and geometry.	Simulations Video-based Technologies
Research/Study Skills	
Students do not know how to display information and interpret graphs.	Graphics

EXHIBIT III-3

CURRICULUM FRAMEWORK



any subject area or discipline where technology will be applied.

Typically, a scope and sequence includes a specification of the skills and knowledge for each grade. The scope and sequence might also specify at what grade level a specific skill or concept is to be introduced, mastered or applied. For example, a grade 6 teacher might introduce students to a set of specific writing skills or techniques and expect that grade 7 and 8 teachers will do further teaching of those skills until mastery is achieved. Teachers in grades 9 through 12 can then be expected to have students apply the writing skill in a variety of contexts. Word processing is a specific computer application that assists teachers in focusing on aspects of writing such as organizing ideas, structuring paragraphs, and editing and rewriting using the text editing capabilities.

The framework constitutes the sum of what needs to be learned in any content area or discipline. The framework can be developed at many levels. For a specific grade, the framework can specify what is to be taught in a subject content area, such as social studies. The framework can also be used to delineate the content of a subject across several grade levels, such as American History as it is taught throughout the secondary grades. Each cell in the matrix represents a unit of instruction, a multiple-lesson unit that combines the three elements of discipline-specific process skills, information and concepts, and technology skills.

In addition to describing the instructional sequence (introduce, master, apply), the scope and sequence of instructional content would also guide teachers in selecting objectives at all cognitive levels, as appropriate. Bloom's

Taxonomy of Educational Objectives is the most familiar listing of these cognitive levels. We suggest a simpler set of three levels: acquisition, transformation, and evaluation.

An outcome of the curriculum assessment and design task is that teachers wishing to incorporate technology into the curriculum will be able to refer to an updated scope and sequence of skills and knowledge in each subject area or skill area. A similar scope and sequence needs to be developed for the technology skills and knowledge that are to be required of all students.* Exhibit III-4 displays a shell for defining the scope and sequence of three components of an integrated curriculum framework, but should not be considered comprehensive without attention to learning/study and thinking/reasoning skills. To maintain a focus on the basic elements of the design process, these two areas are not used in the examples.

Many teachers are familiar with the development and completion of a curriculum framework such as that shown in Exhibit III-4. School staff members are able to identify a rough scope and sequence of information and concepts in each of the disciplines or subjects being studied. There is much less specification of what process skills the students will be required to master, nor is there a scope and sequence of how these skills will be sequenced across the grades. While it may be difficult to specify a precise scope and sequence of technology skills across the grades, teachers will need to construct a rough sequence that assigns specific skills to certain grades, and possibly even subjects.

*See, for example, *Computers in Education Goals and Content.* Sacramento, CA: California State Department of Education, 1985.

EXHIBIT III-4

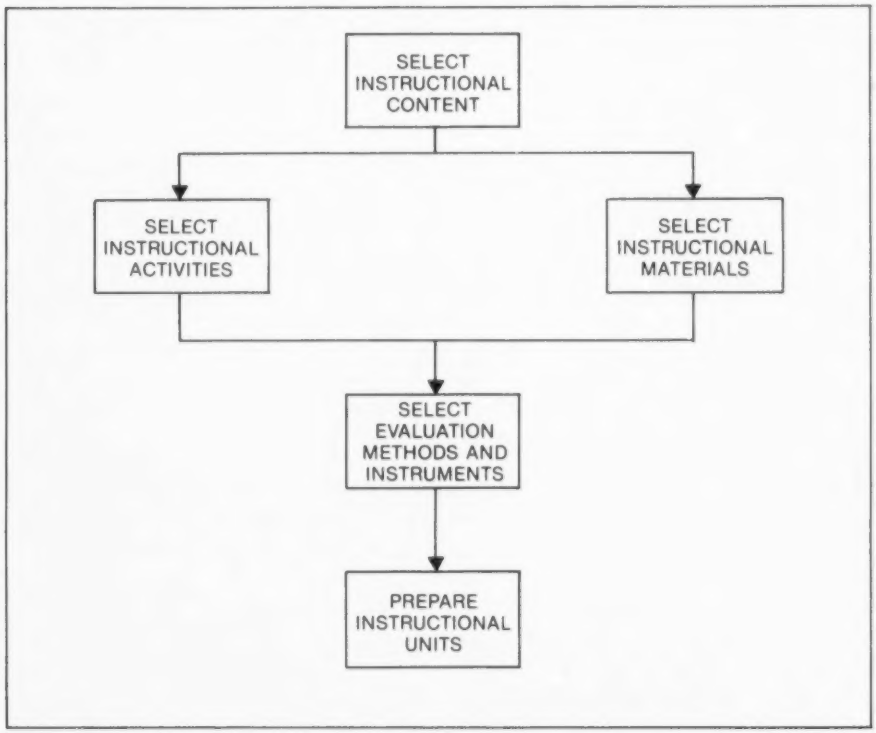
CURRICULUM FRAMEWORK

SCOPE AND SEQUENCE SHELL

Grade	Discipline-Specific Process Skills	Information/ Concepts	Technology Skills
K-6			
7			
10-12			

TECHNOLOGY IN THE CURRICULUM

INSTRUCTIONAL DEVELOPMENT



B. Instructional Development

Moving from a curriculum framework such as that illustrated in Exhibit III-3 to instructional plans requires that teachers select instructional content, identify prerequisites, and map out instructional strategies (see Exhibit III-5). This process results in the development of unit plans that serve as the guide to instructional applications and lesson plans. Guidelines to develop instructional strategies and applications are outlined here.

These applications and lesson plans take the form of instructional packages. Thus, the instructional development phase (see Exhibit III-5) is composed of two major activities:

- Develop instructional unit plans
- Develop instructional packages

The unit plan (see Exhibit III-6 for an example) is a blueprint for integrating technology applications in the curriculum. It is an overview of an instructional sequence of several lessons focused on a set of discipline-specific skills, information and concepts, and technology competencies. The instructional package is a detailed set of instructions for implementing the technology supported unit. Appendix B contains an example of a package developed based on the unit plan shown in Exhibit III-6.

Our approach to incorporating technology applications in the curriculum is based on the use of instructional unit plans. These plans do not deal with the entire curriculum, but with those portions where technology is being applied. The assumption supporting this approach is based on the recognition that incorporating technology into the curriculum will not be done all at once, but in stages. Teachers need to use an incremental approach to the task even though the grand design must be in place.

To guide the overall integration process and detailed lesson planning, teachers need to prepare instructional unit plans that specify how the technological skills and the curriculum objectives are to be blended. The plan helps to organize the skills, instructional strategies and

resources into a coherent system for guiding the delivery of instruction. Because the intent is to teach and use technology skills in all subject areas, we suggest that teachers use an instructional unit plan as the principal means of integrating technology skills into the major subject areas.

The instructional unit allows for a modular integration with a primary focus on those learning tasks and outcomes that will yield early and significant success. Over time, the growing collection of individual units will constitute a substantial portion of the total curriculum.

With the development of instructional unit plans completed, teachers prepare instructional packages—lessons and materials that are used to guide day-to-day instruction. These applications typically take the form of instructional packages (or kits) that contain detailed instructions for teachers and students, materials needed for instruction, and samples of instructional strategies and activities.

In this instructional development activity, instructional objectives, method, and performance assessment measures are specified. This activity occurs simultaneously with staff development training for faculty members who are responsible for implementing the instructional plans. Detailed instructional development is considered a necessary part of any overall staff development plan. The instructional development task includes the following steps:

1. select instructional content
   a. discipline-specific process skills
   b. information/concepts
   c. technology skills
2. select instructional activities
   a. strategies
   b. methods
3. select instructional materials
   a. equipment
   b. software
   c. support materials
4. select evaluation methods and instruments
5. prepare instructional units

These steps result in the development of unit plans and instructional packages. Each of these steps is described in detail below. In completing each step, the instructional development team will need to decide the level of detail to be used for the unit plan (the blueprint); our experience is that details about content, activities, materials and so forth should be left to the instructional package. The unit plan should describe the general approach.

Thus, the development of instructional applications involves the determination of the expected, specific student competencies; the instructional approach and methods to be used; strategies, materials and equipment required; grouping modes and organizational arrangements (lab, classroom, etc.) and the methods for assessing student performance.

1. Select Instructional Content

Selecting content assumes that there is already in place a clear scope and sequence of content for each of the dimensions of the curriculum framework: 1) process skills, 2) information/concepts, and 3) technology skills. The two other curriculum content elements, thinking/reasoning skills and learning/study skills should also be in place, but we do not incorporate them into our examples. The scope and sequence allows teachers to select content for their students that is based on what they have already mastered and what they will need to be prepared to master at the next grade level. The scope and sequence specifies the domain of content that needs to be mastered in a subject or discipline leads to the development of unit plans or modules (Exhibit III-6), which in turn leads to the most precise specification of content for the instructional materials and lessons.

In selecting instructional content, teachers may need to be specific by choosing or developing objectives according to their cognitive level and instructional sequence (see above). Exhibit III-7 illustrates how the basic scope and sequence shell presented in Exhibit II-4 can be expanded to add details about cognitive levels and instructional sequence. As an illustration, writing skills are specified on the left of the chart and cognitive levels across the top. The instructional sequence is determined by the teacher as she selects or writes objectives to fill in the shell, noting whether the specific objectives will be **introduced** to the students for the first time, whether the students have already been introduced to the objective and now require teaching for **mastery**, or whether the objective has already been mastered and needs to **apply** the skills or knowledge to different tasks.

EXHIBIT III-6

INSTRUCTIONAL UNIT PLAN

PROBLEM SOLVING COMPONENT MODULE #1

TITLE:

CONCEPTS:

OBJECTIVES:

STUDENT ACTIVITIES:

INSTRUCTIONAL RATIONALE:

INSTRUCTIONAL MATERIALS:

RESOURCES:

CLASSROOM SCHEDULE:

CLASSROOM MANAGEMENT/ ORGANIZATION:

INSTRUCTIONAL DESIGN:

A. PROCESS OBJECTIVES:

B. CONTENT OBJECTIVES:

C. TECHNOLOGY OBJECTIVES:

PREREQUISITES:

TEACHER'S NOTES:

A master copy is located in Appendix B.

EXHIBIT III-7

CURRICULUM FRAMEWORK

SCOPE AND SEQUENCE OF WRITING SKILLS

Cognitive Levels and Instruction Sequences

Writing Skills	Acquisition			Transformation			Evaluation		
	Intro	Master	Apply	Intro	Master	Apply	Intro	Master	Apply
Topic Development									
Planning									
Drafting									
Revising									
Editing									
Publication									

A complete sample is located in Appendix C.

Without well defined frameworks like those in Exhibit II-4 and III-7, teachers will not be able to plan appropriate instruction across subject areas and grades. This is particularly problematic with respect to technology applications instruction where students sometimes receive a similar **introduction** to a particular set of skills in more than one grade or subject area, and do not receive instructions for **mastery** or extended **application** at all. A chart such as in Exhibit III-7 can be prepared for any process skill area, or for the other two instructional content components, information/concepts and technology skills.

Exhibit III-8 displays how a specific writing skill (revision) can be broken down into several subskills. Each of these can then be sequenced and integrated with essential information and technology skills to form an integrated instructional unit.

Typically, teachers at each grade level will have a syllabus or course outline that specifies the scope of content to be covered. In language arts, for example, the teacher may be dealing with a particular genre of writing (e.g., poetry or fiction) and have specific literary works identified for instruction. In addition, the teacher will need to have identified the specific literary analysis concepts that he or she will teach, either as an introduction, for mastery, or for application. This content is seldom articulated in a curriculum plan using a scope and sequence. Typically, teachers agree on specific genres and literary works, but seldom specify the concepts to be addressed at each grade. It is a difficult task, but one that would contribute to more effective instruction.

The third component of instructional content is the technology skills. Exhibit III-9 presents a simple set of competencies that can be adapted by most school districts. The instructional sequence in Exhibit III-10 is an example of how a district might choose to sequence the competencies across grade levels.

Note that the required competencies are for *all* students. While schools must provide a variety of electives for students wishing to specialize on progamming or particular tool applications, their first obligation is to insure that all of their graduates master the minimum requirements. In this case, the minimum is working knowledge of word processing and an introductory knowledge of the other tool applications. The degree of use of these competencies is a function of the type and degree of incorporation of the tool competencies into each subject area. Exhibit III-11 is an example of a detailed scope and sequence of technology tool competencies for three tool applications — word processing, databases, and spreadsheets.

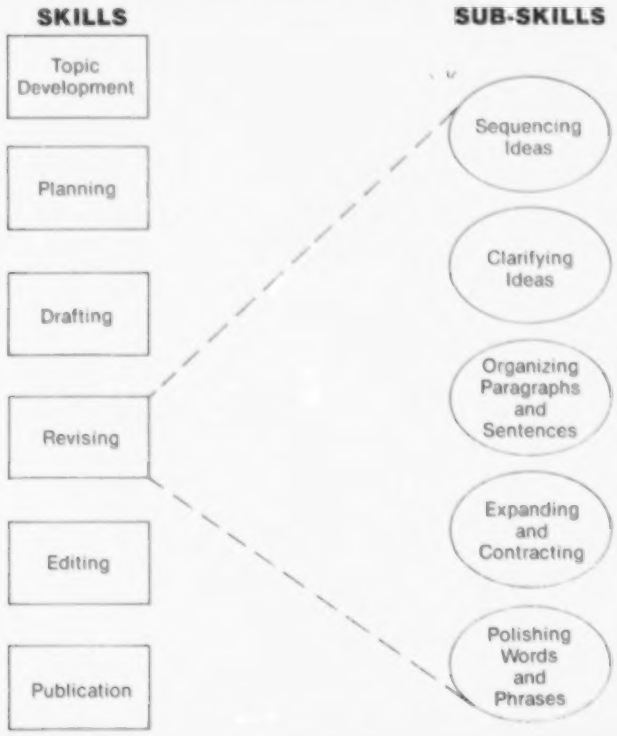
Because required technological skills will change so rapidly and students will acquire many skills outside of school, any scope and sequence of them will have a limited utility. However temporary such sequences may be, they form a useful means of organizing instruction across grades and subjects.

EXHIBIT III-8

CURRICULUM FRAMEWORK
SELECTING INSTRUCTIONAL CONTENT

SCOPE AND SEQUENCE OF WRITING SKILLS

THE WRITING PROCESS



2. Select Instructional Activities

By their very nature, computers and other technology tools will stimulate and perhaps even require a wider repertoire of instructional strategies and activities than are employed in the typical classroom, particularly in secondary schools. While teachers have to choose among several strategic options, some of these options will be increasingly less viable. For example, whole group instruction, the predominant instructional mode in secondary schools, may be inconsistent with optimal uses of computers. In most cases, technology will require more individualized approaches.

In addition to the influences of the technology, the implementation of an integrated curriculum such as that described in Chapter II, with its balanced focus on procedural skills and knowledge as well as information, may prompt teachers to expand their instructional strategies and methods. Research and experience have noted the need to apply a wide range of teaching techniques to accomplish the objectives of an integrated curriculum.

Using technology well will require some modifications in the technology of teaching. A major intent of technology-supported intructional improvement is to revitalize teaching as well as learning. It is important that teachers develop the ability to model, demonstrate, and coach students in the appropriate applications of new learning and information tools to important skills. The best teachers have a repertoire of teaching strategies and techniques from which they select those most appropriate to match the learning task, the learner's style, and their own preferences.

The selection of appropriate instructional strategies is one of the most complex tasks that a teacher must undertake. The determination of strategies and tactics must be based on the teacher's assessment of the content, the learners (as individuals and as a group), and his or her own pedagogical strengths and weaknesses.

Research and experience have noted the need to employ a wide repertoire of teaching techniques in addition to lecture/presentation. Teachers need to select techniques and strategies that complement the capabilities of the available technologies.

3. Select Instructional Materials

It is unlikely that the textbook will be replaced any time soon as the primary instructional material in the classroom. Nevertheless, there is a growing trend toward the use of supplementary instructional materials, of which computer software, videotapes, videodiscs, and related materials form a part. In some cases, teachers will need to develop instructional materials that support the technology applications they wish to implement. With respect to selecting appropriate software and related instructional materials, the most challenging task will be to match software to the specific requirements of the instructional objectives and activities.

As indicated previously, the primary focus of this handbook on computer applications is on general purpose tool software, with less attention given to instructional software dealing with drill and practice and tutorials. Tool software is available in sufficient quantity and quality to accommodate a wide range of student (and teacher) capabilities. To select appropriate tool software, use the following criteria:

- ☐ **Easy to Learn.** How long will it take students to master the basic operations of the software. For example, will students be able to manipulate text with a word processor within one or two class periods?
- ☐ **Easy to Use.** Are the keyboard commands easy to remember and execute? Are help menus easily accessible within the program?
- ☐ **Range.** How wide a range of capabilities can the software serve? Does it have a low enough "floor" to accommodate the less proficient students? Is its "ceiling" high enough so that the more able students can use it for more sophisticated operations?

EXHIBIT III-9

COMPUTER COMPETENCIES

I. Foundation Skills
- A. Required
  1. keyboarding/touch-typing
  2. operation and care of hardware/software/peripherals
  3. using programmed software
- B. Optional
  1. history of the computer
  2. career opportunities
  3. societal impact of the computer
  4. misuses of the computer

II. Computing Skills
- A. Required
  1. algorithms
  2. basic computer operating system functions
  3. computer languages (awareness level)
- B. Optional
  1. programming aids (authoring tools)
  2. computer languages

III. Application Skills
- A. Required
  1. word processing
  2. databases
  3. graphics
  4. communications
  5. spreadsheets

  } introductory level, with applications in subject areas as required
- B. Optional
  1. specialization in one or more applications as stand-alone skills

EXHIBIT III-10

SCOPE AND SEQUENCE OF COMPUTER COMPETENCIES

Grade	Required Computer Competencies	Curriculum Integration
K		
1		
2	FOUNDATION SKILLS	*PILOT PROJECT* COMPUTER BASED SOFTWARE AND MATHEMATICS
3		
4		
5		
6	COMPUTING SKILLS APPLICATION SKILLS WORD PROCESSING	*PILOT PROJECT* WORD PROCESSING AND WRITING
7		
8		
9	APPLICATION SKILLS DATABASES GRAPHICS COMMUNICATIONS SPREADSHEETS	*PILOT PROJECT* APPLICATION SKILLS IN THE CONTENT AREAS
10		
11		
12		

The distinctions made by Taylor (1980) between tool, tutor, and tutee applications of the computer appear to be merging in the more sophisticated tool software. Many tools have detailed help menus and instructions which serve as a tutor to the user; some also are modifiable (i.e., computer as tutee) through built-in programming languages. Still other tools are combinations, including a word processor, a spreadsheet or file program, and a graphics capability.

Also important is the quantity and quality of support materials available to help teachers use the software appropriately. While instructions on the use of the software should be considered a minimum, these materials alone often are not adequate for applications to specific curriculum objectives and learning activities.

The selection and development of instructional materials is a central consideration in the development of student and teacher materials, but there are several additional elements that need to be addressed. For the teacher package, the following elements are important:

- **Essential program elements.** An annotated list of the essential components of the program should be included in the package, so that teachers can monitor their own implementation.
- **Directions.** Directions for each activity should be provided, particularly emphasizing instructional strategies, techniques, and management practices to be employed.
- **Visuals/Illustrations.** All of the visual aids to be used should be included.
- **Evaluation measures and methods.** Tests and other forms for collecting information on student performance.

For the student package, the following elements are important:

- **Directions.** Clear specifications for how the student is to use the software to accomplish each objective.
- **Forms.** Any forms that the student will need to complete during the activity.
- **Software.** Instructional or tool software, and blank discs as needed.
- **Readings.** Assigned readings in the text or in other resource materials.

4. Select Evaluation Instruments and Methods

The focus of the evaluation in an instructional unit is on student performance in mastering the objectives of the curriculum. While some assessment may be directed toward the mastery of technology competencies, such as whether the student can execute block movement of text using a word processor, the principal focus needs to be on mastery of the discipline-specific skills and knowledge that comprise the cur-

riculum. Ideally, student performance evaluation should focus on each of the elements of the integrated curriculum. For this purpose, objective or criterion referenced measures are most appropriate. In areas such as writing, teachers are using student and teacher checklists to monitor skills acquisition. Many technology skills may be best assessed through similar means.

5. Prepare Instructional Units

Once steps 1 through 4 have been completed, the development team can turn to the actual preparation of unit plans and packages. The **plan** is the vehicle for organizing decisions about content, activities and materials into a guide for instruction. The **package** is the guide for day-to-day instruction.

The unit plan (Exhibit III-6) deals with a set of lessons organized around a major topic area. The topics, which serve as the central focus of the unit, usually are broad, discipline-specific process skills. Examples are revision (writing), formulating hypotheses (science), and representation (art). In some cases, however, the unit is based on a major content area in a subject, such as poetry (English/language arts), mass (science), and color (art). In keeping with the conceptual framework, the unit identifies objectives in a minimum of three areas: process, content and technology. The other components of the unit plan are typical of most instructional plans.

Because the technology skills are sequenced across the elementary and secondary grades, it is possible to specify the skills that are to be taught at each grade level. The instructional unit provides a means of assuring their integration with content and process skills. When the subject area curriculum is organized by the major discipline-specific process skills, one unit plan can be developed for each skill area to be covered at each grade level. Thus, in language arts, unit plans might be developed for each of the major writing skills (e.g., topic development, planning, drafting, revising, editing and publication). Another organization scheme might focus on various literary analysis skills. Using the unit plan as a guide, teachers can develop sets of lessons that direct day-to-day instruction.

The unit plan serves as a general guide to instruction that may cover a substantial block of time (e.g., 10 to 20 class periods or lessons). As such, it cannot provide the level of detail of a daily lesson plan. Unit plans can be modified to accommodate different content and skills. Because it is difficult and perhaps impossible to revise even one curriculum area all at once, the instructional unit allows for a more manageable modular approach without the piecemeal fragmentation that impedes expansion and elaboration. Each module can be modified to accommodate different combinations of skills and information; as a sufficient number of modules are created, the curriculum evolves within an overall framework.

It is difficult to revise an entire curriculum area all at once to incorporate new tool technologies. Not only is the time requirement considerable, a pilot test mode may be necessary to work out the "bugs" in the process. Based on experience with the pilot test of a single unit plan or instructional package, it will then be possible to prepare and implement additional unit plans and packages. Thus, for example, during the first year of incorporating word processing into the classroom, the teacher may use only one or two units that cover only a portion of the school year. Expansion may need to be put off until the following school year, when new units might be put in place. The modular approach of the unit plan and package allows for an incremental implementation based on the readiness of the teacher and the availability of materials. Instructional unit plans can be modified to incorporate new content and process skills.

With generic tool software such as word processing, database programs, and spreadsheets the development and implementation of new unit plans can be accomplished with less effort than instructional software. Once teachers are familiar with the capabilities of a tool, they will find it easy to extend its use into other areas of their curriculum. Once a selection of modules has been created dealing with different process skills and content, teachers will be able to exchange unit plans and instructional packages and customize them for their own use.

To develop unit plans, MEC uses a process that requires teachers to select skills and information from each of the areas of the integrated curriculum (i.e., information, discipline-specific process skills, learning/study skills, thinking/reasoning skills, and technology tool skills). Most often content area curricula are organized almost exclusively around content. We suggest instead that the unit have as its core focus a discipline-specific skill or set of skills that needs to be taught for acquisition, mastery or application. With such a focus, the teacher can then select whatever information or content needs to

be learned and would serve as an appropriate accompaniment or vehicle for teaching the skill(s). We recommend the incorporation of appropriate learning/study skills and thinking/reasoning skills into the unit.

If a comprehensive curriculum framework is in place, developing a unit plan is essentially a matter of selecting the best mix of content, process skills and technology tools to accomplish an integrated instructional approach. With an overwhelming amount of content to cover, teachers are always forced to select that which they think is appropriate for their students. By moving discipline-specific skills to the "center" of the unit, teachers can provide a critical focus to instruction. For example, if the central focus of the unit is on learning a few strategies for revising written work, the teacher can use as models literature that is part of the curriculum content as well as the students' own writing. Some instruction in outlining skills also might be blended in, serving as a support to the teaching of the writing skills. These three areas constitute the minimum subject matter objectives for a unit plan. It also is important, however, to include attention to some higher order thinking/reasoning skills such as analysis, as well as some instruction and use of a word processor to manipulate text to experiment with several different revisions of an essay or paragraph. of the writing skills. These three areas constitute the minimum subject matter objectives for a unit plan. It also is important, however, to include attention to some higher order thinking/reasoning skills such as analysis, as well as some instruction and use of a word processor to manipulate text to experiment with several different revisions of an essay or paragraph.

Although many teachers combine content teaching with skill development, the process usually is less than comprehensive. Also, technology tool skills typically are not viewed as part of the overall subject matter curriculum. The unit development process provides a framework for assuring attention to all the objectives while fostering an integrated teaching model. Most effective teaching is a blending of objectives from all or most of the five areas of objectives. The unit plan serves as a vehicle for developing instruction around this concept based on a comprehensive approach to curriculum development.

EXHIBIT III-11

TECHNOLOGY TOOL SKILLS SCOPE AND SEQUENCE

WORD PROCESSING

COMPETENCIES	LEVEL I	LEVEL II	LEVEL III
Terminology	word processing insert delete overwrite word wrap files text edit	tab justification reformat undo fonts page breaks text blocks	scrolling windows macros
Commands	insert delete overwrite save/load print	find/replace set tabs set justification set page breaks reformat block movement	use sub/superscripts prepare columns centering
Functions/ Operations	text entry naming files printing text files using help menus	outlining file transfer copying files delete files	checking spelling checking grammar/usage footnotes indexes headers/footers
Applications	essays journals	newspapers letters electronic mail	research report journal articles

TECHNOLOGY TOOL SKILLS SCOPE AND SEQUENCE

DATABASES

COMPETENCIES	LEVEL I	LEVEL II	LEVEL III
Terminology	database field file record character field name page	procedure command keyword	expression store value variable
Commands/Functions/ Operations	create add copy list index save load search	sort delete change insert find keyword search	modify report labels programming commands merge store
Applications	find data	data entry design search parameters	conduct search

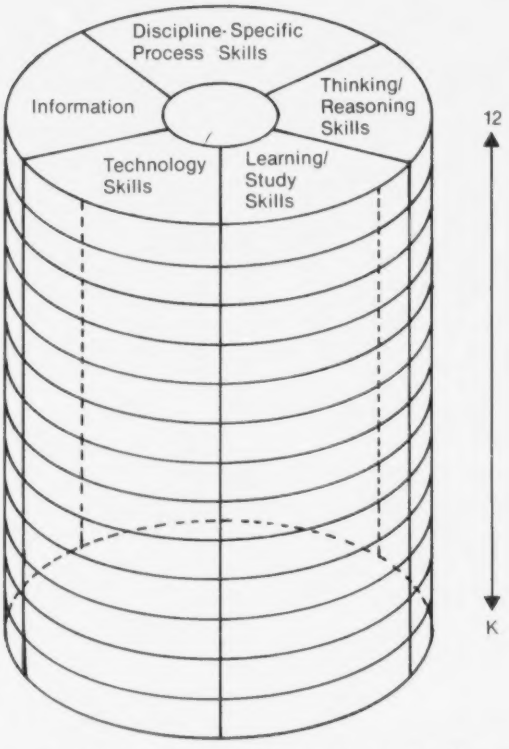
TECHNOLOGY TOOL SKILLS SCOPE AND SEQUENCE

SPREADSHEETS

COMPETENCIES	LEVEL I	LEVEL II	LEVEL III
Terminology	spreadsheet cell matrix words/labels numbers/formulas delete edit	replication format	variable value
Commands/Functions/ Operations	load save copy edit format delete arithmetic (mean, sum, round, count) decimals	move print replicate recalculate logical operators arithmetic (max, min, square root)	split screens financial calendar special arithmetic (exp, log, sin/cos/tan)
Applications	calculations	spreadsheet design	problem design and analysis

EXHIBIT III-12

AN INTEGRATED K-12 SCOPE AND SEQUENCE MODEL



A rough hierarchy of what is taught in each curriculum area.

One way of conceptualizing the task is to think of a K-12 curriculum as depicted in Exhibit III-12. The integrated curriculum model presented in Exhibit II-1 can be extended to encompass a K-12 scope and sequence in any discipline or subject. Teachers have the task of specifying a teaching/learning scope and sequence for each of the segments of the "cylinder" at each grade level. While such specification may not be widely used in schools, the new information technologies will need to be matched by new technologies of teaching.

The unit plan serves as the blueprint for the development of the detailed instructional packages that guide day-to-day instruction. The instructional packages expand upon the unit plan by including teacher and student directions, specific instructional activities, a detailed schedule, and all materials needed to implement instruction. Student performance monitoring methods and instruments are also included. Appendix contains a sample instructional package.

As most teachers know, the simple delineation of steps masks considerable complexity. There are many issues and constraints that need to be addressed in implementing the steps delineated here.

These steps constitute a basic process for developing instructional unit plans and instructional packages. The three part focus on information/concepts, process skills and technology skills may be supplemented by attention to learning/study skills and to thinking/reasoning skills, all of which are blended into a coordinated curriculum content.

Summary of Unit Development Process

1. Outline the various units which comprise a year's course. Identify the topic addressed in the unit. State the rationale for the inclusion and location of the unit in the course.
2. Develop a statement of general purpose (rationale) for the unit or module (e.g., students will be able to "re-vision" their written communication using several strategies).
3. Identify the domain of objectives (i.e., information processing skills, learning-study skills, thinking/reasoning skills, and technology tool skills that need to be taught at the particular grade level). Outline in detail (via an advance organizer) the various topics and subtopics which comprise the unit.
4. Select the process skill area to serve as the focus of the unit (e.g., revision skills).
5. Select appropriate information (facts, concepts, understandings, attitudes) that is part of the required course syllabus (e.g., descriptive writing in three genres).
6. Select appropriate learning/study skills that complement and enhance the instruction in the process skills (e.g., outlining and organization skills).
7. Select appropriate thinking/reasoning skills in analysis, synthesis and evaluation that complement and enhance the instruction in the process skills (e.g., classification skills).
8. Select appropriate technology skills that can be used to support learning in other areas (e.g., use of word processor).
9. Identify what prerequisite knowledge and skills students will need to have in order to begin instruction in the unit (e.g., general familiarity with the writing process and literary analysis skills).
10. Identify the general strategies to be used to accomplish the purpose and objectives of the unit (e.g., direct whole group instruction, use of readings as models of descriptive writings, teacher modeling). Organize and schedule strategies across the instructional periods. Describe how the strategies will blend instruction in all of the objectives.
11. Describe the activities to be conducted by the students (e.g., reading, writing, discussion, homework assignments).
12. Identify the instructional methods used in the unit.
13. Identify the various learning activities in which the students will engage as they proceed through the unit.
14. Specify the resources utilized in the unit. Identify the instructional methods employed in the course.
15. Identify the instructional materials needed to support all of the objectives, not just those dealing with content (e.g., list of process skills, definitions of key terms, discussion questions).
16. Identify several means of evaluating whether the objectives have been accomplished (e.g., objective tests, writing assignments, observation). Describe products students will prepare.
17. Specify the course schedule with an emphasis on correlating items such as dates of class meetings, topics, assignments, schedule for lab, etc.
18. Identify various activities and assignments of a review and/or remedial nature to which a student would be recycled in order to correct certain learning deficiencies uncovered by the formative test and establish a correspondence between items missed on the formative test and learning corrective.
19. Select or develop test(s) checklists and other measures to assess student performance in as many of the objective domains as necessary and appropriate.
20. Construct a unit evaluation form relative to the effectiveness of the instructional unit.

C. Considerations

The curriculum design process delineated here may appear somewhat formal for describing the often opportunistic and serendipitous process whereby teachers incorporate technology into the curriculum. Some may argue that the design process might be collapsed into a simple decision to try an application in one particular area rather than go through the complex process of curriculum assessment, technology applications monitoring and the deliberate selection of targets of opportunity. In some cases, particularly where the experience of other schools or teachers can inform our judgment, such a short-circuiting of the process may not result in any problems. In general, however, we advocate that teachers become actively involved in the design process so that subsequent implementation can be accomplished by staff who have a stake in, and experience with, the decision.

The case of the use of word processing to teach writing is an appropriate example. The evidence is mounting that word processing *can* have a positive impact on students' writing performance. Merely "attaching" word processing to writing instruction, however, may not yield significant gains (particularly given the cost of the technology) unless the writing curriculum and instructional process are exemplary. Students can be introduced to a word processor through modeling and demonstrations provided by the classroom teacher. Even if there is only one computer available, the teacher can do a lesson with the entire class in which the use of a word processor will facilitate the development of a writing demonstration. In this way the teacher can show the students the power and capabilities of the tool without placing any demands for learning the tool on them.

We have illustrated instructional objectives in the area of writing and include descriptions of suggested instructional methods and materials and assessment measures. For each curriculum objective, several instructional applications may exist and students will need repeated practice on their skills in order to achieve mastery. Furthermore, the spiral curriculum in a scope and sequence, provides for practice at successively higher levels of performance as the student progresses from elementary/intermediate grades to secondary school program.

By having teachers first assess the writing curriculum and identify its shortcomings, the introduction of word processing as a writing tool will be made more deliberately. Teachers will then define process skills or the technology competencies. During these curriculum design activities, teachers select and develop a set of process skills for each of the areas of interest.

Revising the curriculum framework (step 4) assumes that the availability of specific technology tools will require that the content, scope and sequence, and emphasis of the curriculum will be changed. Some changes will be required to accommodate the new technology (for example, using computers for storing and organizing information). The more important changes will take place because the new technologies make obsolete or unnecessary components of the traditional curriculum (for example, the need to require memorization of data may be given less attention and the need to analyze and manipulate that information will be emphasized).

The instructional unit or modular approach is consistent with the staging and phasing notion in the CAPS program planning model. That is, we recognize, based on experience, that districts have neither the resources nor the time to implement whole, full-scale programs.

Instructional development is a complex process. Many decisions made in developing instructional units or modules require a view of how the entire technology integration program will be accomplished. We provide a brief discussion here of some important considerations.

Level of Integration with Curriculum

Whether students are taught technology skills in a separate "literacy" course or whether all or most subject area teachers will have responsibility for teaching specific skills will influence many other decisions about the use of technology in the curriculum. Will, for example, the teacher of writing be required to teach her students how to use a word processor, or will she be expected only to have students apply the skills they have developed in a separate course. *Teaching* the technology skills poses different requirements than *using* them. Subject area teachers may be more comfortable as users than as teachers of technology skills. Less time will be required away from the subject matter for use than for teaching.

In some schools, however, it may not be possible to have a separate course for teaching technology literacy skills. It may be necessary to have subject area teachers accept responsibility for teaching some skills. An allocation of responsibility for teaching these skills in each subject area may require some preparation.

Some content area teachers may feel that such instruction is the responsibility of the math teachers; others may complain about the loss of time they can give to their own subject matter. Integration with all subject matter can be an effective means of assuring technology skills development *and* application to subject matter. The investment of time given to technology skills instruction within the content areas will yield substantial returns in terms of increased learning of the subject matter itself.

Integrating the teaching and use of technology skills into the subject-matter curriculum is useful for several reasons. Students will be more motivated to learn and apply the skills if they understand how they help them to master subject matter and discipline-specific skills. When students can apply the skills to meaningful content (i.e., content that they are required to learn) they are likely to develop the technology skills more completely and effect the important transfer to all of their school work.

Skills Development

Attaining a better balance between teaching facts and teaching skills requires not only an identification of the important skills in each subject area, but the development of strategies for teaching them. Because most teachers do not have as much experience in teaching skills as they do in teaching concepts and facts, they may need to give some attention to skills development strategies in their curriculum work.

The following are some basic prerequisites for teaching skills:

- conscious awareness by the student of the task and its relationship to the development of the skill
- student's understanding of how to perform the task
- student's ability to focus on task without distractions
- modeling of the task in the initial stages of instruction
- sufficient practice of the task over a period of time
- immediate feedback on performance of task
- understanding of applicability of task to immediate needs in the subject areas

Skills instruction needs to be provided in four stages:

1. **Readiness.** Students attempt to use the skill as best they can, with the teacher promoting their receptivity to improve their use of the skill.
2. **Introduction.** Teachers provide specific instruction, identifying the component procedures and providing examples.
3. **Reinforcement.** Teachers provide repeated practice, and additional, as-needed instruction and review.
4. **Extension.** Students learn to transfer the skills to learning of new content or skills.

Beyer (1983) indicates that the research suggests that students learn skills best when they:

1. are consciously aware of what they are doing and how they do it;
2. are not distracted by other inputs competing for attention;
3. see the skill modeled;
4. engage in frequent—but intermittent (not massed)—practice of the skill;
5. use feedback received during this practice to correct their use of the skill;
6. talk about what they did as they engaged in the skill;
7. receive guidance on how to use a skill at a time when they need the skill to accomplish a content-related goal; and
8. receive guided opportunities to practice the skill in contexts other than that in which the skill was used.

Based on these instructional strategies, teachers and administrators will need to:

1. examine their curriculum and instructional practice to determine what is being taught;
2. determine what instructional strategies teachers are using to teach learning/study skills; and
3. encourage and train all content area teachers to teach and reinforce through application a specific set of learning skills.

Modular Development

The use of instructional units is recommended because it allows for a reasonable pace for revitalizing the curriculum. Despite the major changes that are required in order to realize a truly integrated curriculum, it cannot be accomplished all at once. There are other benefits to the instructional unit approach. A major consideration is the readiness of the teachers; they will need time and opportunities to revitalize their own knowledge and skills. If teachers are to play a central role in reshaping curriculum, schools will need to invest in staff development. That investment will need to be made over a multi-year period.

Another benefit of the modular approach is that risks are reduced. Given that there are many issues and constraints not yet adequately addressed with respect to technology application, the instructional unit approach accommodates pilot testing and the "learning from our tries" that is required if we are to realize meaningful educational reform through technology applications. Small focused development efforts allow for a true test of whether and how technology can be incorporated appropriately into the curriculum. Attempts to spread our knowledge, resources and energies too thinly will likely result in failure, causing educators to dismiss a valuable resource.

Technology will give new shape to learning, allowing all of us to do more thinking while the computer does the work.

D. Summary

Success in incorporating new technologies into the curriculum will be determined by many factors. Preeminent among them is the degree to which teachers and administrators can use the technology as a stimulus and a tool to accomplish much-needed curriculum revitalization. The process described in this handbook provides a means of undertaking the task. The process steps, models and exhibits are based on actual classroom applications.

At the *curriculum design* stage, teachers and administrators need to determine the yield they can expect to get from a particular application. Tool applications have a higher potential yield in that they introduce to students generic skills that are important for them to master with respect to the technology and which enable them to accomplish a revitalized curriculum more easily and productively.

While a detailed evaluation and refinement of curriculum is not necessary to incorporate technology, failing to do so incurs risks that the technology will become an appendage or that it will perpetuate outmoded forms of curriculum and instruction. Teachers and administrators need to take advantage of the opportunity that the availability of technology provides to rethink what is important. We believe that a revitalized curriculum will offer more opportunities for using technology well.

At the *instructional development* stage, unit plans allow for modular implementation and an incrementally paced implementation. Teachers and administrators will need to take care that the modular approach does not result in increased fragmentation. Thus the need for a comprehensive curriculum framework.

The process described in this handbook is not a quick fix to the need to make appropriate applications of technology in education. The investment made in a comprehensive process—one that addresses the whole curriculum—will yield high returns for students and teachers.

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APPENDIX A

CAPS GUIDEBOOK

Checklist of Planning Steps

This checklist can serve as a review of the planning process described in this manual. You may want to use it to monitor your progress or to explain your work to the school committee and other groups.

1. Preliminary Activities

____Form the planning committees

____Establish broad direction

____Conduct orientation activities

____Inventory current computer application

____Identify planning resource needs

2. Integrating Computers into the Curriculum

____Develop broad goal statements

____Develop student competency statements

____Set planning priorities

____Develop curriculum objectives

____Develop instructional strategies and applications

3. Staff Development

____Identify required staff competencies

____Determine actual staff competencies

____Establish staff development program

4. Hardware and Software Acquisition

____Establish selection criteria and process: software and hardware

____Prepare procurement specifications

5. Organization and Implementation

____Provide for program coordination and implementation

____Develop logistical support system

____Develop materials and equipment support system

EXHIBIT III-6

INSTRUCTIONAL UNIT PLAN

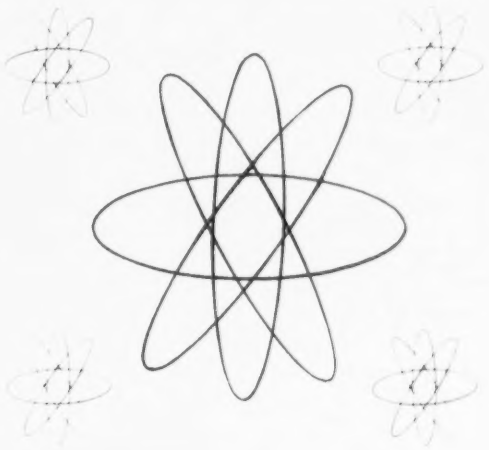
PROBLEM SOLVING COMPONENT MODULE #1

TITLE: Problem Solving in Science Using a Database (Chemical Elements)

CONCEPTS: A computerized database facilitates the problem-solving process by allowing the student to organize, reorganize and sort large amounts of information for analysis and assistance in solving problems.

OBJECTIVES: After completing this unit students will be able to:

1. Use the Appleworks database to arrange, find and cross reference data about 30 common chemical elements
2. Solve problems related to the characteristics of certain chemical elements by manipulating the Appleworks database



INSTRUCTIONAL RATIONALE:

Now, more than ever before, scientists are using a large number of tools to collect data about the world. However, one of the problems that they face is how to organize all the data and information collected so that it can be readily used to systematically and quickly solve problems.

In this lesson, the student, like the scientist, will be confronted with a similar problem. The student will use a computerized database tool which allows scientists to organize large quantities of data and which makes it easy for them to examine it in many different ways. The instructional rationale are:

1. to introduce the use of a database as a problem-solving tool in science
2. to enable students to recognize the appropriate applications of a database
3. to allow students to go beyond the level of simple data input, recall, and listing, toward evaluating what they see and making inferences about what it means

INSTRUCTIONAL MATERIALS:

1. Apple IIe or IIc Computer System
2. Activity cards "Elements"
3. Problem Statements
4. Appleworks Integrated Software package
5. Student Directions

CLASSROOM SCHEDULE:

Days 1-2 Traditional classroom setting

Days 3-5 Computer Labs

Time: 5 45-minute class sessions

APPENDIX B

CLASSROOM MANAGEMENT/ORGANIZATION:
The class should be organized into groups of 2 or 3 students per group.

PREREQUISITES:
1. Keyboarding skills
2. Familiarity with Appleworks Integrated Software
3. Introduction to Elements, Atomic Structure and Periodic Table

STUDENT ACTIVITIES:
1. Students, in groups of 2 or 3, examine activity cards. Student should suggest methods of organization of the information. Introduce problem statements.
2. Students suggest ways to arrange the information in order to solve the problem statements. Suggest possible use of a database computer program.
3. Allow students to attempt to create database using Appleworks from the information on the activity cards.
4. Present students with completed database file "Elements" and have them manipulate this file in order to answer the problem statements.
5. Discuss results with class. What rearrangement was needed to solve each of the problems?
6. Discuss with class other uses of a database in science.

TEACHER NOTES:
Teachers should familiarize themselves with Appleworks Integrated software. An Apple computer system with two drives is preferred. However, the program will run with one drive. (See "Other Activities" on Appleworks menu.)

RESOURCES:
Appleworks Manual
Appleworks Tutorial

INSTRUCTIONAL DESIGN:

A. PROCESS OBJECTIVES:

After completing this activity students will be able to:

1. recognize the need to organize data in order to facilitate the problem solving process
2. recognize which data arrangements are necessary to facilitate the investigation (change variables, category headings, etc.,) and solve the problem

B. CONTENT OBJECTIVES:

After completing this unit students will:

1. develop a greater familiarity with some of the common elements
2. identify the major categories under which elements can be classified—metals, non-metals and inert variables
3. recognize the relationships between an element's properties and its usefulness

C. TECHNOLOGY OBJECTIVES:

After completing this unit students will be able to:

1. create a database from a listing of related information
2. manipulate a database in order to establish relationships between categories of information

APPENDIX C

CURRICULUM FRAMEWORK

SCOPE AND SEQUENCE OF WRITING SKILLS

Cognitive Levels and Instruction Sequences

Writing Skills	Acquisition			Transformation			Evaluation		
	Intro	Master	Apply	Intro	Master	Apply	Intro	Master	Apply
Topic Development									
Planning									
Drafting									
Revising									
Editing									
Publication									

STAGE THREE: INTEGRATING TECHNOLOGY INTO CURRICULUM, CLASSROOM MANAGEMENT AND SCHOOL ADMINISTRATION

1. An administrative plan has been developed.

- ☐ Administrators have been involved in the development of the administrative plan.
- ☐ The technological awareness level of all administrators has been examined and increased where needed.
- ☐ Administrative application needs of the central office and each of the principals' offices have been identified and agreed upon.
- ☐ The scope and timing of the administrative plan have been set.

2. A teacher-support plan has been developed.

- ☐ Principals have been involved in the development of the teacher-support plan and provision has been made for principal training, when necessary, prior to working with teachers.
- ☐ Teachers in each school have volunteered or been selected to participate.
- ☐ Programs for teacher use have been selected, depending heavily on teacher recommendations.
- ☐ Training and other learning opportunities for teachers have been set up.
- ☐ Each principal has a plan for sharing various uses of technology to support the classroom with all teachers.

3. A curriculum program plan has been developed.

- ☐ Student competencies have been identified.
- ☐ Curriculum objectives have been developed.
- ☐ Instructional strategies have been designated.

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